The NOAA Environmental Modeling System at NCEP

Mark Iredell and the NEMS group

NOAA/NWS/NCEP

Environmental Modeling Center

March 31, 2014

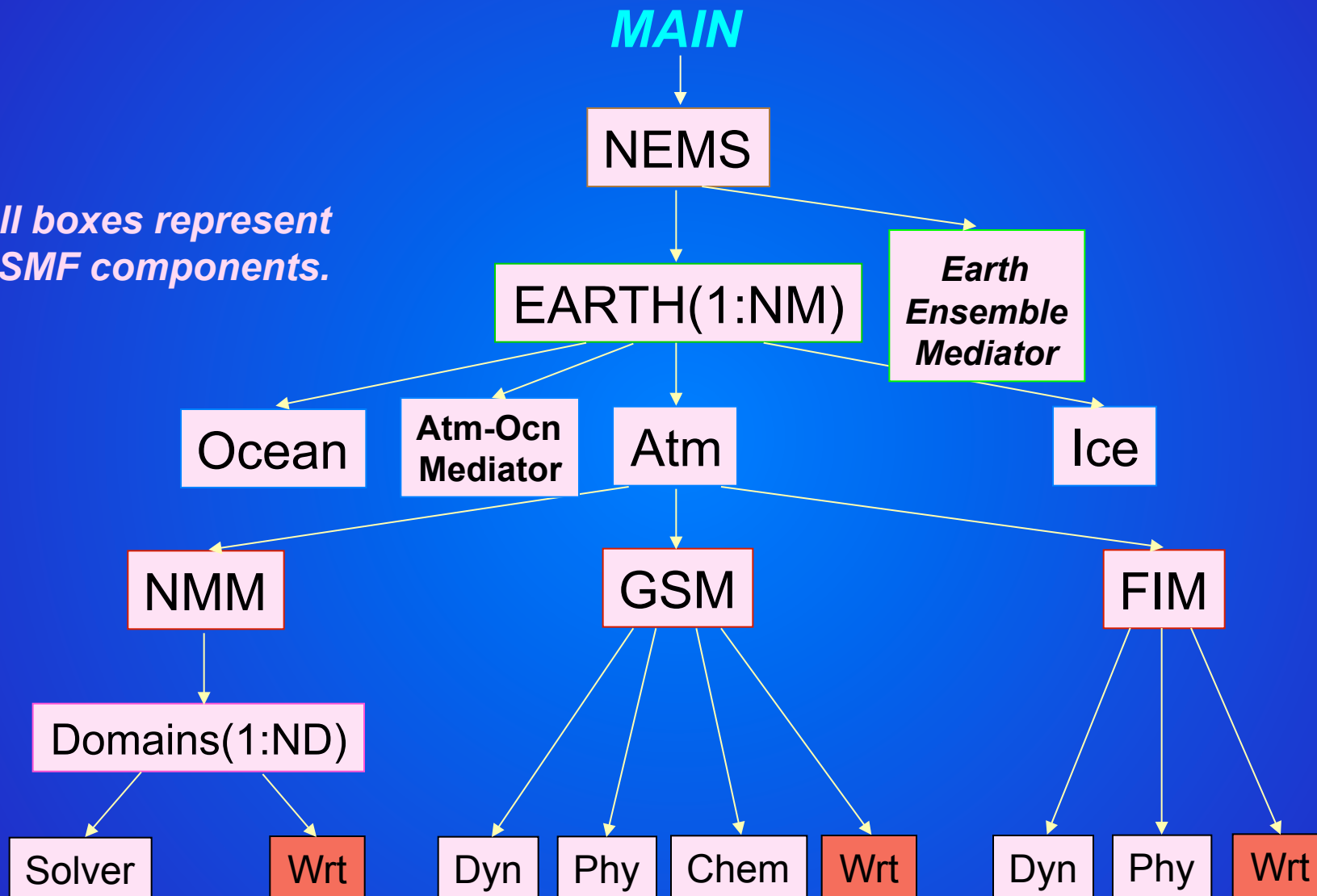# What is NEMS?

- NEMS stands for:
  NOAA **E**nvironmental **M**odeling **S**ystem

- A shared, portable, high performance software superstructure and infrastructure

- For use in operational prediction models at the National Centers for Environmental Prediction (NCEP)

- Eventual support to community through the Developmental Test Center (DTC)

Motivation for NEMS

– Develop a common superstructure that can be shared by NCEP models.

– Modularize large pieces of the models with ESMF components and interfaces.   *http://www.earthsystemmodeling.org/*

– Isolate history/restart output in a common Write component.

– No intrusion into the science code and parallelization in the respective models.

NEMS Structure

MAIN

NEMS

EARTH(1:NM)

Earth Ensemble Mediator

All boxes represent ESMF components.

Ocean

Atm-Ocn Mediator

Atm

Ice

NMM

GSM

FIM

Domains(1:ND)

Solver   Wrt

Dyn   Phy   Chem   Wrt

Dyn   Phy   Wrt

Past NEMS Implementations

- 2011
  - NMM-B with static nests (4 children; 1 grandchild)

- 2012
 - NEMS GFS Aerosol Component (NGAC)

The NUOPC Layer

- Make collaboration easier in building modeling systems.

  - Defines conventions and templates for using ESMF.

  - Includes compliance checking to guide users in the use of compliant model components.

- A prototype of the layer has been bundled in ESMF since release 5.2.0r. *NEMS/NUOPC is now using ESMF 6.3.0r*

- Used in atmosphere-ocean coupling in NEMS

Today we ran the first successful two-way coupling of NCEP GSM and GFDL MOM5 inside NEMS.
Now comes the scientific effort of tuning the coupling.

Coupling of Atmosphere and Ocean in NEMS
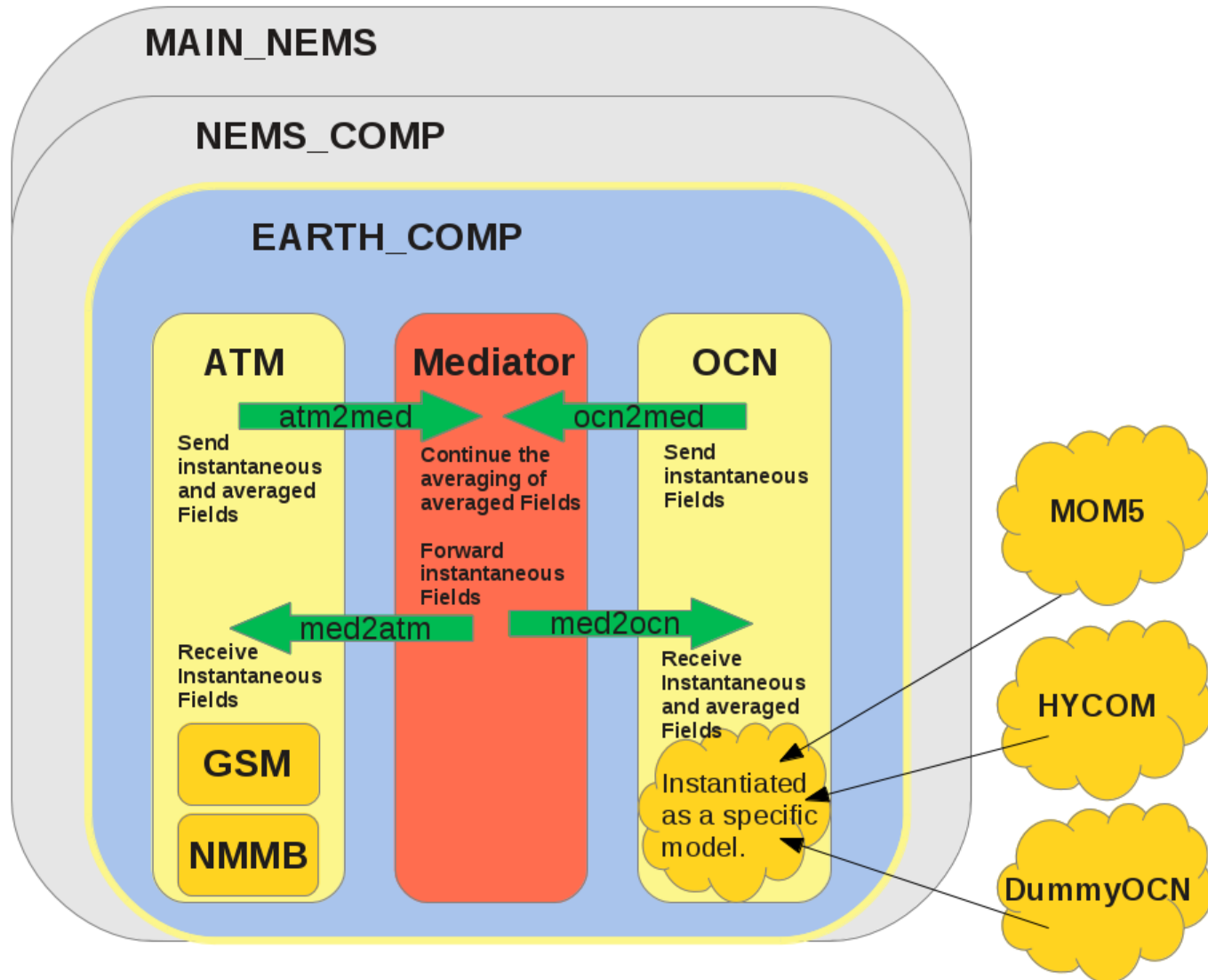
NUOPC Physics Driver Schematic

Atmosphere Model including Dynamics

Dynamical equations, advection, horizontal mixing, diffusion.

standard interface for model physics

Δt, u, v, w, T, θ, p, z, q_x, c_x, a_x
destaggered

Tendencies
and Updates

Atmospheric Physics Driver
(init, run, finalize modes)

Modified Kalnay Rules Layer

Initialize
Physics
Tables and
Databases

Init
Mode

Radiation

Deep and
Shallow
Cumulus

Surface
Layer

PBL and
Vertical
Mixing

Micro-
physics

Finalize
Mode.

Output
Diagnostics
• fields
• rates
• budgets
• others

NEMS Delivery Plans

- 2015
  - GFS
  - GEFS
  - Postprocessor
  - NUOPC Physics Driver

- 2016+
  - Whole Atmosphere Model (WAM)
  - Coupled ocean atmosphere
  - HWRF / NMM-B (2-way telescoping moving nests)
  - Tiled land model
  - NetCDF output
  - NMM-B nested in GFS
  - Multimodel ensemble
  - Climate Forecast System

Summary

- The NOAA Environmental Modeling System is being built to unify operational systems under a single framework in order to more easily share common structures/components and to expedite interoperability.

- The first two systems under NEMS have been implemented into NCEP operations with others to follow in the next few years.

- The NUOPC layer will be used to make collaboration with other groups less difficult when building/coupling modeling systems.

- Incorporation of a NUOPC physics driver can help standardize the often complex connections to physics packages thereby enhancing their portability.